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DEVICE FOR PRESSING ON A RACK

The invention relates to a device for pressing a rack onto a pinion, having a pressure piece and a stop element, in accordance with the preamble of claim 1.

The invention also relates to a device for pressing a rack onto a pinion, in accordance with the preamble of claim 19.

A device of the generic type is known from DE 198 11 917 A1.

Rack and pinion steering systems for motor vehicles usually have a steering housing, in which a rack is mounted such that it can be displaced longitudinally. A pinion which is mounted rotatably in the steering housing engages into the toothing of the rack and, when the steering column which is connected fixedly in terms of rotation to the pinion is rotated, brings about the lateral displacement of the rack, which in turn leads to pivoting of the steered wheels of the motor vehicle via track rods and steering knuckles. The engagement of the pinion into the rack is maintained without play by a pressure piece which bears against the rack opposite the pinion pressing the rack against the pinion under spring prestress. Here, it is known from the general prior art for the pressure piece play to be set via a setting screw which in the process also influences the spring prestress.

Here, the pressure piece has to be designed in such a way, or press against the rack in such a way, that coupling of the rack and the pinion can be maintained without play of the teeth which are in engagement with one another. Here, faults have to be taken into consideration with regard to the eccentricity of the pinion, its axial play and the wear of the teeth.

Furthermore, the mechanism has to be capable of enduring jolts which originate from the steered wheels when the latter strike an obstacle, for example.

The document which forms the generic type, DE 198 11 917 Al, has disclosed a coupling mechanism for a rack with respect to a pinion, which mechanism has a spring for pressing the pinion and the rack against one another, the spring being set up for the purpose of exerting its action in accordance with at least two stages of pressure which follow one another. Here, the spring is configured as an elastomer which has at least two contact faces between the setting screw and the pressure piece. The fact that the pressure takes place at least in two stages achieves a situation where oscillations and jolts which tend to decouple the rack from the pinion and cause noise are damped to a pronounced degree, as the second stage of pressure replaces the first stage as soon as the oscillations or jolts exceed the capabilities of intervention of the first stage. In this way, an increased pressing force is obtained, as a result of which the rack and the pinion are coupled in an improved manner and the noise which is produced is reduced.

However, a disadvantage of the document which forms the generic type is the large tolerance of the spring force with small pressure piece play. The friction in the steering system is changed by the large tolerance, as a result of which the straight line stability behavior of the motor vehicle is influenced negatively. Moreover, it is a disadvantage of the document which forms the generic type that the spring force is relatively susceptible to temperature fluctuations. In addition to this, the spring force of the elastomer changes over its service life.

Firstly, it is essential in the device for pressing a rack onto a pinion that the friction in the steering system is low when traveling in a straight line; secondly, a playfree toothing engagement is to be ensured reliably during steering at great steering speeds. Moreover, the device has to be as insusceptible as possible to temperature fluctuations and wear.

The present invention is therefore based on the object of providing a device for pressing a rack onto a pinion, having a pressure piece and a stop element, which device eliminates the disadvantages of the prior art, has, in particular, very good damping properties with low wear, prevents the occurrence of noise reliably and can be manufactured and assembled inexpensively.

According to the invention, this object is achieved by the characterizing features of claim 1.

According to the invention, this object is likewise achieved by the characterizing features of claim 19.

As a result of the fact that, in accordance with claim 1, the second stage of the pressure is carried out by contact faces of the pressure piece and the stop element which are in each case oriented toward one another coming into contact with one another, advantageous pressing which acts in at least two stages of the pressure piece onto the rack is achieved. In a basic position, that is to say in a position in which no dynamic forces or forces as a result of the engagement of the pinion into the rack are active which are suitable for displacing the rack in the direction of the pressure piece, only the first stage of the pressure is active, that is to say the spring element which is arranged between the pressure piece and the stop element. In this position, the contact

faces of the pressure piece and the stop element are situated at a distance from one another.

The spring prestress of the spring element results in a pressure piece play, in which only the spring element is active, that is to say the first stage of the pressure. The spring element can be manufactured within narrow tolerances in a customary manner and therefore exerts a defined spring force on the rack. Satisfactory straight line traveling of the motor vehicle is possible as a result with a very small axial pressure piece play. As soon as large tooth separating forces or other forces which move the rack in the direction of the pressure piece occur during steering, the spring force of the spring element is overcome, as a result of which the contact face of the pressure piece makes contact with the contact face of the stop element. As a result of the fact that, according to the invention, at least one contact face is of resilient configuration, the second stage of the pressure begins as soon as the contact faces make contact with one another. The second stage of the pressure or the contact face of resilient configuration preferably has a great spring force, as a result of which a playfree toothing engagement is ensured when steering at large steering speeds. This playfree toothing engagement reduces the development of noise during steering.

The resilient configuration of at least one of the contact faces begins to act only when the contact faces make contact with one another. Prior to this, the resilient contact face can be relieved of stress or the resilient contact face is stressed only by the contact.

As has been proven in tests, the device according to the invention has a long service life with an unchanged action. Moreover, in contrast to the device which is known from DE 198 917 Al, the device according to the invention is

relatively insusceptible to temperature fluctuations. It is advantageous if the pressure piece is formed from metal, preferably aluminum, and the stop element is formed from metal, preferably steel. Moreover, it is advantageous if the spring element is formed as a metallic helical spring.

The formation, in particular, of the pressure piece and the stop element from metal makes particularly exact manufacture possible with low tolerances. As a result, the pressure piece play, in which only the spring element is active which is arranged between the pressure piece and the stop element, can be kept particularly small, as a result of which the noise which is produced is minimized.

As a result of the formation of the pressure piece, the stop element and the spring element from metal, the device has two metallic springs, namely the spring element which is clamped in and the at least one resilient contact face, which have a long service life and are substantially independent with respect to temperature fluctuations. As a result, the friction in the steering system can be set exactly. It has been proven in tests that the solution according to the invention can be manufactured and assembled particularly simply and inexpensively.

The object according to the invention is advantageously likewise achieved by the features of claim 19. Here, in contrast to the solution in accordance with claim 1, the contact faces of the pressure piece and the stop element bear against one another. Here, the advantage consists in that no noise is produced as a result of the contact face of the pressure piece coming into contact with the contact face of the stop element. Here, it is advantageous if the contact faces are prestressed against one another, in order to counteract wear which occurs or a seating process over the

service life of the device. The prestressing of the contact faces can therefore achieve a situation where the contact faces still bear against one another even if, for example, the pinion is abraded on account of wear.

It is advantageous if the pressure piece has a circumferential surface and a pin which protrudes in the direction of the stop element and the exposed end of which is configured as a contact face, and the stop element has an annular circumferential surface and an end wall which is configured as a contact face.

Here, the end wall of the stop element can be deflected in the basic position by the contact face of the pin. There can be provision here for the contact face of the stop element to be deflected by from 0.1 to 0.5 mm.

In order to generate a progressive spring characteristic diagram, there can be provision for the contact face of the pin to be of cambered configuration.

Advantageous refinements and developments of the solution according to the invention result from the further subclaims. In the following text, two exemplary embodiments of the invention will be shown in outline form using the drawing, in which:

Fig. 1 shows a section through the device according to the invention in a basic position, in a refinement in which the contact faces are arranged at a distance from one another;

Fig. 2 shows a section through the device according to the invention in a basic position, in a refinement in which the contact faces bear against one another;

Fig. 3 shows a section through the device according to the invention in a basic position, in a refinement in which the contact faces bear against one another and a pin of the pressure piece is of resilient configuration;

Fig. 4 shows a section through the device according to the invention in a basic position, in a refinement in which the contact faces bear against one another and both a pin of the pressure piece and an end wall of the stop element are of resilient configuration; and

Fig. 5 shows an illustration of the pressure piece with a quarter cut away.

Rack and pinion steering mechanisms, in particular for motor vehicles, having pressure pieces for coupling a rack with respect to a pinion are already sufficiently known, for which reason reference is made only by way of example to DE 29 28 732 C2 and DE 198 11 917 A1.

Therefore, in the following text, only the features which are relevant for the invention will be discussed in greater detail. The basic principle of a coupling mechanism of this type for a rack and its drive pinion is also sufficiently known from the general prior art and from the abovementioned patent publications.

As can be seen from Fig. 1, the device according to the invention for pressing a rack 1 onto a pinion (not shown) has a pressure piece 2 and a stop element 3. A spring element 4 which is configured as a compression spring is arranged between the pressure piece 2 and the stop element 3. Here, the spring element 4 exerts the first of at least two stages

of the pressure which follow one another and press the pressure piece 2 against the rack 1.

The pressure piece 2 essentially has an annular circumferential surface 5, a base part 6 which faces the rack 1, and a pin 7 which protrudes beyond the circumferential surface 5 in the direction of the stop element 3.

The pressure piece 2 is preferably formed from aluminum and manufactured by die casting.

As can be seen from Fig. 1, the pressure piece 2 is arranged in a receptacle space 8 of a steering housing 9. Here, the base part 6 of the pressure piece 2 is oriented in the direction of the rack 1. Here, the base part 6 has a profile which is adapted to the adjoining circumference of the rack 1. The receptacle space 8 in the steering housing 9 is usually configured as a cylindrical bore, the circumferential surface 5 of the pressure piece 2 being adapted substantially to the internal diameter of the receptacle bore 8.

In one embodiment, the base part 6 which faces the rack 1 can be provided with a plastic insert which serves as a contact face for the rack 1. As an alternative, the base part 6 or the entire pressure piece 2 can also be configured from plastic.

In the exemplary embodiment, there is provision for the pressure piece 2 to be configured from metal, preferably from aluminum, a sliding foil 10 being arranged between the inner wall of the receptacle space 8 and the circumferential surface 5 of the pressure piece 2. Here, the sliding foil 10 has a sliding base 11 as a bearing point for the rack 1. A plastic insert in the base part 6 or a similar friction reducing insert is therefore not necessary. The sliding foil 10 can

preferably be arranged in the receptacle space 8 by means of an interference fit. The sliding foil 10 or the sliding base 11 makes it possible, firstly, that the pressure piece 2 can transmit the required pressing force, and secondly the sliding base 11 forms a bearing surface which does not cause any significant frictional forces or wear during displacement of the rack 2.

Reference is made to DE 103 09 303.6 with regard to one particularly preferred refinement of the sliding foil 10 and of the circumferential surface 5 of the pressure piece 2.

In the exemplary embodiment, there is provision for the pressure piece 2 to be arranged in the sliding foil 10 or to be connected to the latter by means of an interference fit. In a simple way, this can be realized by an external diameter of the circumferential surface 5 of the pressure piece 2, which external diameter is greater than the internal diameter of the sliding foil 10. In the present exemplary embodiment, however, the circumferential surface 5 has a ring 12. Here, the interference fit is between the external diameter of the ring 12 of the circumferential surface 5 and the internal diameter of the sliding foil 10.

The interference fit between the sliding foil 10 and the inner wall of the receptacle space 8 takes place in an analogous manner between the pressure piece 2 and the sliding foil 10. For this purpose, the sliding foil 10 has circumferential sliding foil rings 13 which have an external diameter which is greater than the diameter of the receptacle space 8. The sliding foil 10 can have, for example, a wall thickness of preferably 1 mm, the sliding foil 10 being configured more thickly in the region of the sliding foil rings 13, with the result that the wall thickness is, for example, from 1.1 mm to 1.5 mm, preferably 1.2 mm.

Furthermore, as can be seen from Fig. 1, the receptacle bore 8 is closed by the stop element 3 at its opening which faces away from the rack 1. In the exemplary embodiment shown, the stop element is configured here as a setting screw 3 which is screwed into the receptacle bore 8 in a defined manner. Here, the setting screw 3 has an annular circumferential surface 14 and an end wall 15. The setting screw 3 is preferably formed from steel and is manufactured by deep drawing.

A sealing ring 16 can be provided for sealing between 5 the inner wall of the receptacle space 8 and the setting screw 3.

As can be seen from Fig. 1, the spring element 4 is configured as a helical spring which is arranged substantially within a hollow space formed by the circumferential surface 5 of the pressure piece 2 and is clamped between the base part 6 of the pressure piece 2 and the end wall 15 of the setting screw 3.

The pressure piece 2 and the setting screw 3 in each case have contact faces 17a, 17b which are oriented toward one another and are arranged at a distance from one another in a basic position. Here, at least one of the contact faces 17a, 17b is of resilient configuration, with the result that the second stage of the pressure begins as soon as the contact faces 17a, 17b make contact with one another. In the exemplary embodiment shown, the contact face 17a of the pressure piece 2 is formed by the exposed end of the pin 7 which protrudes beyond the circumferential surface 5 of the pressure piece 2 in the direction of the setting screw 3. Here, the pin 7 extends coaxially with respect to the axis of the pressure piece 2 and is located in the center of the helical spring 4 and is surrounded by the latter. The pin 7 is configured in one piece with the pressure piece 2. The contact face 17a is thus preferably formed from aluminum.

In the exemplary embodiment, there is provision for the contact face 17b of the setting screw 3 to be formed by the end wall 15. In the exemplary embodiment, furthermore, there is provision for the contact face 17b or the end wall 15 to be of resilient configuration. Here, the wall thickness of the end wall can be, for example, from 0.6 to 0.9 mm, preferably 0.7 mm. The end wall 15 or the contact face 17b can deflect accordingly, as a result of this refinement or as a result of the fact that there is a clearance behind the end wall 15.

The contact face 17b is set by screwing in the setting screw 3. The pressure piece play or the distance between the contact face 17a and the contact face 17b results from the spring prestress of the helical spring 4 which is supported on the setting screw 3, which is screwed into the receptacle space 8, and, on the other side, presses the pressure piece 2 against the sliding foil 10 or the sliding base 11 and thus the rack 1 against the pinion (not shown but which is likewise mounted in the steering housing 9). Only the spring force of the helical spring 4 acts before the contact face 17a makes contact with the contact face 17b or while the distance is being overcome between the contact face 17a and the contact face 17b. As soon as the spring force of the helical spring 4 has been overcome and the contact face 17a has made contact with the contact face 17b, the resilient configuration of the setting screw 3 becomes active. In order to limit the spring travel of the contact face 17b or to define a second pressure piece play while the second stage of the pressure is active, the pressure piece 2 and the setting screw 3 each have a second contact face 18a, 18b which are oriented toward one another and, in the basic position, are at a distance from one another which is greater than the distance between the first contact faces 17a, 17b. The second contact face 18a of the pressure piece 2 and the second contact face 18b of the

setting screw 3 therefore serve as end stops for the movement of the pressure piece 2 in the direction of the setting screw 3. The second pressure piece play is thus defined fixedly by the components, that is to say the pressure piece 2 and the setting screw 3, and is realized by the contact faces 18a, 18b.

The contact face 18b of the setting screw 3 introduces the forces directly into the steering housing 9 without a spring action. While the second pressure piece travel is being covered, that is to say after the contact face 17a has made contact with the contact face 17b, the force which occurs at the strut is stored in the resilient setting screw 3 and thus returned again during steering. As a result, a playfree toothing engagement is also ensured at high steering speeds. The high spring rate of the setting screw 3 stores a large spring force in the second pressure piece travel having narrow tolerances. The playfree toothing engagement which results from this reduces the noise development during steering.

As can be seen from Fig. 1, the second contact face 18a of the pressure piece 2 is formed by the exposed end, which is oriented in the direction of the setting screw 3, of the circumferential surface 5 of the pressure piece 2. The second contact face 18b of the setting screw 3 is formed by the end, which is oriented in the direction of the pressure piece 2, of the annular circumferential surface 14 of the setting screw 3.

In order to attain a progressive spring rate at the setting screw 3 or the contact face 17b of the setting screw 3, it has proven advantageous for the contact face 17a to be of cambered configuration. That is to say, the contact face 17a can be configured as a curved surface, for example having a radius of from 100 to 300 mm, preferably 200 mm. Here, the radius of the contact face 17a can be adapted to the wall thickness of

the end wall 15, with the result that the stresses which occur in the end wall 15 or the setting screw 3 can be controlled. A further advantage of the cambered refinement of the contact face 17a consists in that the pressure piece 2 can thus be oriented satisfactorily on the rack 1 and is not overgoverned by the contact with the contact face 17b.

The spring rate of the helical spring 4 can be, for example, from 200 to 350 N/mm, preferably 280 N/mm. The spring rate of the setting screw 3 or of the contact face 17b can be, for example, from 1,000 to 25,000 N/mm and rise to a spring force of from 2,500 N to 3,500 N over a spring travel of 0.2 mm.

The spacing between the first contact face 17a of the pressure piece 2 and the first contact face 17b of the setting screw 3 in the basic position can be, for example, from 0.02 mm to 0.1 mm, preferably 0.05 mm. The spacing between the second contact face 18a of the pressure piece 2 and the second contact face 18b of the setting screw 3 in the basic position can be, for example, from 0.15 mm to 0.3 mm, preferably 0.2 mm.

The solution according to the invention is preferably suitable for rack and pinion steering systems for motor vehicles, but it goes without saying that it is not restricted thereto. The device according to the invention can also be used in rack and pinion steering systems in other fields.

Figures 2 to 5 show alternative embodiments to Fig. 1. The parts which are denoted by the same designations in Fig. 1 and Figs. 2 to 5 correspond to one another, as long as changes are not referred to in the following text, so that a further description of these parts with regard to Figures 2 to 5 is omitted.

Fig. 2 shows an embodiment, in which the contact faces 17a, 17b bear against one another in a basic position. Here, there is provision for the contact face 17b of the stop element 3 to be deflected by the contact face 17a of the pin 7 in the basic position. Here, there can be provision for the contact face 17b to be deflected by from 0.1 to 0.5 mm in the basic position.

In accordance with Fig. 2, there is provision for the contact face 17a of the pin 7 to be of cambered configuration in order to generate a progressive spring characteristic diagram.

The distance between the contact faces 18a and 18b can be from 0.05 mm to 0.3 mm, preferably 0.1 mm, in the basic position.

The use of a spring 4 can also be dispensed with.

Fig. 3 shows an embodiment, in which the contact faces 17a, 17b bear against one another in a basic position. Here, in contrast to Fig. 2, there is provision for the pin 7 to be of resilient configuration. In accordance with Fig. 3, the end wall 15 is of rigid or substantially rigid configuration. The pin 15 is provided with cutouts 19 which are arranged offset with respect to one another or with notches which lead to the resilient configuration of the pin 7. Here, as also results from Figures 4 and 5, the cutouts 19 are arranged offset with respect to one another both in the axial direction of the pin 7 and along the circumference of the pin 7. In the exemplary embodiment, the cutouts 19 extend over approximately 1/8 - 1/4 of the circumference of the pin. This has proven particularly suitable in tests, it going without saying that the cutouts 19 can also be arranged in a different way in the pin 7 and can have a length which differs from the exemplary embodiment.

As an alternative to a resilient configuration of the pin 7 by the introduction of cutouts 19, there can also be provision, for example, for the pin 7 to be of thin configuration, in such a way that the result is a resilient action. A further possibility of achieving a resilient configuration of the pin 7 can consist in that, for example, the latter is configured partially or completely from a material (modulus of elasticity) which has a desired elasticity. Accordingly known plastics can be used, for example, for this purpose.

It has been proven in tests that a resilient configuration of the pin 7 can be achieved in a particularly simple way by the introduction of cutouts 19.

In accordance with Fig. 3, the resilient configuration of the device according to the invention results substantially from the resilient configuration of the pin 7. In the embodiment which is shown as an alternative in Fig. 4, the end wall 15 also has a resilient configuration, with the result that the resilient action of the device according to the invention results both from the pin 7 and from the end wall 15. Here, in accordance with Fig. 4 in an analogous manner to Fig. 2, there can be provision for the pin 7 and the end wall 15 to already be deflected in a basic position. The prestressing of the contact faces 17a, 17b of the pin 7 and the end wall 15, respectively, achieves the situation where the contact faces 17a, 17b still bear against one another when the pinion, for example, is abraded on account of wear.

Fig. 4 shows a refinement, in which the use of a spring element 4 has been dispensed with. It goes without saying that the use of a spring 4 can also be dispensed with in the embodiment in accordance with Fig. 3 if this appears expedient for the provided application.

Fig. 5 shows an illustration of the pressure piece 2 with a quarter cut away.

In an analogous manner to Fig. 2, there can be provision, in accordance with Figures 3 to 5, for the spacing between the contact faces 18a and 18b to be from 0.05 mm to 0.3 mm, preferably 0.1 mm, in the basic position.

The device according to the invention is not restricted to the refinements shown in the exemplary embodiment. Further possible embodiments or combinations result, in particular, from surveying Figures 1 to 5 together.

List of Designations

1 Rack
2 Pressure piece
3 Stop element, setting screw
4 Spring element
5 Annular circumferential surface
6 Base part
7 Pin
8 Receptacle space
9 Steering housing
10 Sliding foil
11 Sliding base
12 Ring
13 Sliding foil rings
14 Annular circumferential surface
15 End wall
16 Sealing ring
17 a, b First contact face
18 a, b Second contact face
19 Cutouts